Rapid Antiproton Transfers

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Temple Review

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Rapid Antiproton Transfers

- Introduction
- Overview of Each Subproject
  - Beam Line Regulation
  - Software
  - Oscillation Feedback & Control
  - Diagnostics
  - Commissioning
- Summary

Rapid Antiproton Transfers - Introduction

- Current set-up time
  - ~2 hours to load the Tevatron
  - ~1 hour to set up and send pbars to the Recycler
- Motivation for speeding process
  - Increased stacking rates only possible by not building a core – empty the Accumulator when it 'fills up'
  - Maintain as high an average stacking rate as possible – minimal impact on stacking
- Expected set-up time
  - move from shot set up to 'transfers on event'
  - actually, automatic transfers, they occur on event now
  - Unstack/transfer time now ~30 seconds, driven by time to adiabatically bunch, accelerate, and extract pbars from the Accumulator

Rapid Antiproton Transfers – Beam Line Regulation

- Motivation
  - Current AP1 powering scheme – 2 sets of power supplies
  - Ramp beam line on clock events – single set of supplies
- 1.3.6.2.1 Magnetic Field Tolerance
  - Current bi-modal scheme recognized power supply limitations
  - Reverse engineer what regulation is really needed
- 1.3.6.2.2/3 Improve regulation as necessary
  - Preliminary look indicates current regulation may be sufficient
- 1.3.6.2.4 Waveform generator control for AP1
  - standard Fermilab CAMAC cards can be build to support ramping AP1 supplies
  - 15 cards needed at $800 each
  - Can be fabricated and installed in a matter of weeks

Rapid Antiproton Transfers – Software

- 1.3.6.3.2 Support for beam line ramping
  - User friendlier 465 card application
- 1.3.6.3.3 Orbit correction
  - Reverse proton tune-up no longer occurs except as transfer peformance dictates
  - Application needed to read/use beam line BPM data for pbars to make corrections
- 1.3.6.3.4 Lattice measurement
  - Parasitic/rapid beam measurements of beam line lattice will be needed
- 1.3.6.3.1, 6 Sequencer upgrades/other support
  - Next generation sequencer will be required
  - Preliminary work in progress
  - Other new software undoubtedly needed

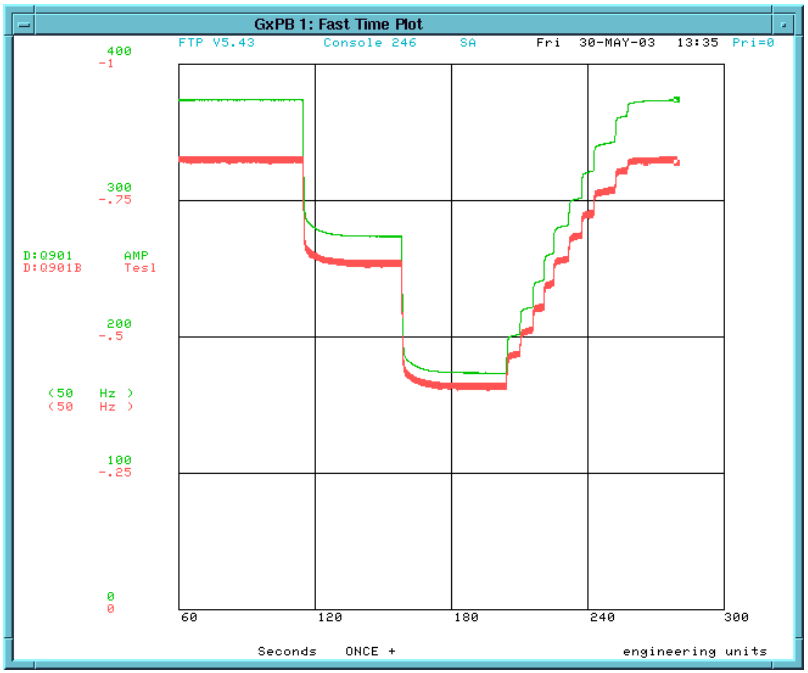
Rapid Antiproton Transfers – Oscillation Feedback & Control

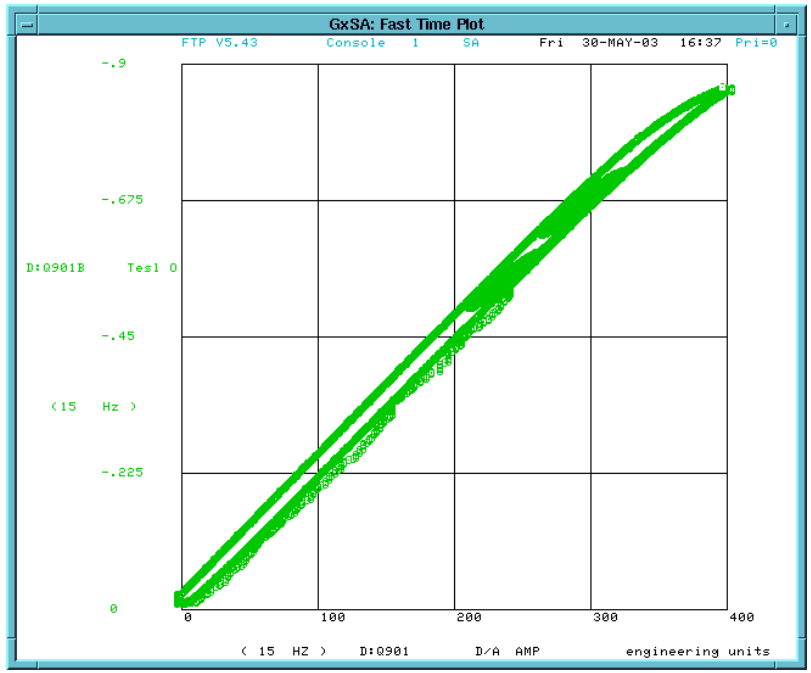
- 1.3.6.4.1 Pbar Injection damper in MI
  - Work in progress by Bill Foster, et al
  - Demonstrated with protons
  - Hardware procured – reversing switches
  - People identified
  - Current specification – damp 1mm distortion in 10 turns
- 1.3.6.4.2 Quadrupole pickup in Accumulator
  - Feasibility studies in progress

Rapid Antiproton Transfers – Diagnostics

- 1.3.6.5.1 Beam line BPM upgrade
  - no routine reverse proton tuneup
  - no Pbar beam line BPM data – intensity too low, bunch structure?
  - outdated processors
- 1.3.6.5.2 Magnetic field probes on beam line elements
  - Proof of principle in progress on a quadrupole
  - easy to install, place into operation (1 day)
  - ~$1500/unit, up to 130 units required (all beam line elements)
  - Identifying critical magnets to instrument

Rapid Antiproton Transfers – Diagnostics





Proof of principle – beam line quadrupole Hall probe

Rapid Antiproton Transfers – Commissioning

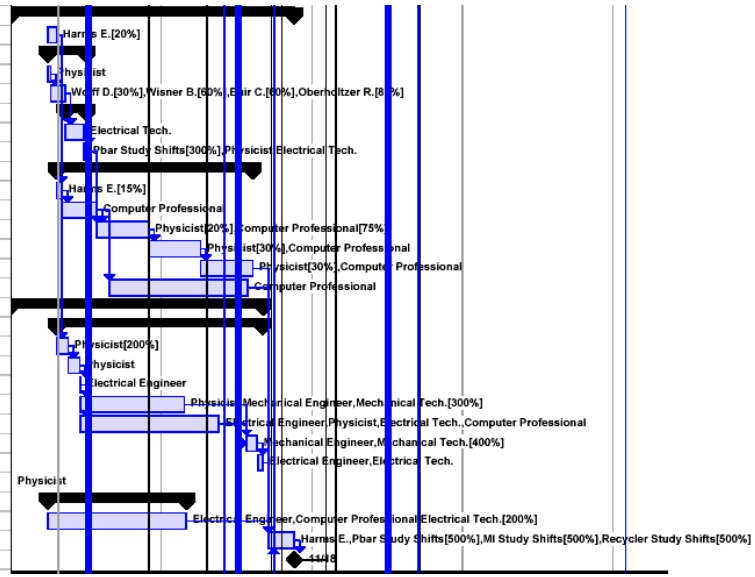
- Phased approach
  - Implement aspects which will benefit Collider operation in short term
  - Complete additional steps in anticipation of Recycler integration

Rapid Antiproton Transfers – Resources

WBS	Subproject	In Charge	Finish Date	M&S Est	M&S Cont
1.3.3	**Pbar Stacking and Cooling**	**Dave McGinnis**	**11/17/05**	**$2,254,000.00**	**46%**
1.3.3.1	Stacking and Cooling Integration	Dave McGinnis	11/4/05	$0.00	
1.3.3.2	Debuncher Cooling	Paul Derwent	6/2/03	$0.00	
1.3.3.3	Stacktail Cooling	Paul Derwent	11/17/05	$1,171,000.00	40%
1.3.3.3.1	Momentum	Paul Derwent	11/17/05	$1,004,000.00	40%
1.3.3.3.2	Betatron	Paul Derwent	11/17/05	$167,000.00	40%
1.3.3.4	Recycler Stacking and Cooling	Sergei Nagaitsev	4/8/05	$0.00	
1.3.3.5	Electron Cooling	Sergei Nagaitsev	1/25/05	$566,000.00	44%
1.3.3.5.1	Commission Full Beamline	Sergei Nagaitsev	3/19/04	$55,000.00	45%
1.3.3.5.2	Design and procure components	Jerry Leibfritz/Sergei Na	1/30/04	$373,000.00	42%
1.3.3.5.3	Disassemble Wideband Facility	Jerry Leibfritz/Sergei Na	6/1/04	$22,000.00	58%
1.3.3.5.4	Transport Components to MI-31	Jerry Leibfritz	7/27/04	$24,000.00	60%
1.3.3.5.5	Install Pelletron at MI-31	Jerry Leibfritz/Sergei Na	8/10/04	$37,000.00	60%
1.3.3.5.6	Commission Pelletron	Sergei Nagaitsev	10/19/04	$0.00	
1.3.3.5.7	Install E-Cool Transferline	Jerry Leibfritz	8/27/04	$23,000.00	40%
1.3.3.5.8	Modifications to MI/RR	Jerry Leibfritz	9/18/03	$15,000.00	40%
1.3.3.5.9	Install Cooling Section in RR	Jerry Leibfritz/Sergei Na	9/6/04	$17,000.00	40%
1.3.3.5.10	Commission Cooling Section	Sergei Nagaitsev	9/23/04	$0.00	
1.3.3.5.11	Commission Electron Cooling	Sergei Nagaitsev	1/25/05	$0.00	
1.3.3.6	Rapid Transfers	E Harms	5/5/05	$517,000.00	60%
1.3.3.6.1	Document Fast Transfer scheme	E Harms	4/21/03	$0.00	
1.3.3.6.2	Beam Line Regulation	E Harms	2/13/04	$12,000.00	40%
1.3.3.6.3	RT Software	E Harms	3/4/05	$0.00	
1.3.3.6.4	Oscillation Feedback and Control	B Foster	1/9/04	$0.00	
1.3.3.6.5	Diagnostics	E Harms	12/16/04	$505,000.00	60%
1.3.3.6.6	Commission Fast Transfers	E Harms	5/5/05	$0.00	

Rapid Antiproton Transfers – Resources

1.3.6	**Rapid Transfers**		**Wed 1/1/03**	**492 days?**	**$0.00**		
1.3.6.1	Document Fast Transfer scheme		Tue 4/1/03	15 days	$0.00	B	
1.3.6.2	**Beam Line Regulation**		**Tue 4/1/03**	**68 days**	**$0.00**		
1.3.6.2.1	Determine magnetic field tolerance		Tue 4/1/03	5 days	$0.00	C	
1.3.6.2.2	Measure and Improve power supply reg		Tue 4/8/03	25 days	$0.00	C	444
1.3.6.2.3	**Ramp waveform control of AP1**		**Tue 5/13/03**	**38 days**	**$0.00**		
1.3.6.2.3.1	Build new 465 cards		Tue 5/13/03	33 days	$12,000.00	B	445
1.3.6.2.3.2	Install and commission new 465 ca		Thu 6/26/03	5 days	$0.00	B	447
1.3.6.3	**RT Software**		**Tue 4/22/03**	**340 days**	**$0.00**		
1.3.6.3.1	Streamline Sequencer		Tue 4/22/03	10 days	$0.00	B	442
1.3.6.3.2	465 card application		Tue 5/6/03	60 days	$0.00	B	450
1.3.6.3.3	Orbit Correction		Tue 7/29/03	90 days	$0.00	B	448,451
1.3.6.3.4	Lattice measurement		Tue 12/2/03	90 days	$0.00	B	452
1.3.6.3.5	TBT correction		Tue 4/6/04	90 days	$0.00	B	453
1.3.6.3.6	RT: other software		Thu 8/28/03	240 days	$0.00	B	451FS+22 days
1.3.6.4	**Oscillation Feedback and Control**		**Wed 1/1/03**	**438 days?**	**$0.00**		
1.3.6.4.1	**MI Injection Damper**		**Tue 4/22/03**	**359 days**	**$0.00**		
1.3.6.4.1.1	Specify necessary damper voltage		Tue 4/22/03	20 days	$0.00	C	442
1.3.6.4.1.2	Determine scope of work		Tue 5/20/03	20 days	$0.00	C	458
1.3.6.4.1.3	Purchase load switches/power amp		Tue 6/17/03	2 days	$0.00	B	459
1.3.6.4.1.4	Specify and fabricate damper picku		Thu 6/19/03	180 days	$0.00	C	460
1.3.6.4.1.5	Specify, design, and build low level		Thu 6/19/03	240 days	$0.00	C	460
1.3.6.4.1.6	Install damper system		Mon 7/26/04	20 days	$0.00	B	461,462,557SS
1.3.6.4.1.7	Test low level		Mon 8/23/04	10 days	$0.00	B	463
1.3.6.4.2	Accumulator Quad pickup	?? Nagaslaev	Wed 1/1/03	1 day?	$0.00	C	
1.3.6.5	**Diagnostics**		**Tue 4/1/03**	**240 days**	**$0.00**		
1.3.6.5.1	P1, P2, AP1, AP3 53 MHz BPM upgrad		Tue 4/1/03	240 days	$500,000.00	C	
1.3.6.6	Commission Fast Transfers		Fri 9/17/04	44 days	$0.00	C	454,455,464,467,557
1.3.6.7	Rapid Transfers Operational (Milestone)		Thu 11/18/04	0 days	$0.00		468



Rapid Antiproton Transfers – Summary

- With the Recycler integrated into Collider operation and high stacking rates, rapid transfers will be vital
  - Unstack and transfer every 30 minutes
  - Interrupt stacking for 1 minute
- 5-fold plan to realize rapid transfers
  - Beam Line Regulation
  - Software
  - Oscillation Feedback & Control
  - Diagnostics
  - Commissioning
- Work begun in some areas, more just around the corner